HUC 10300200 – Lower Missouri Subbasin
Water body identification: 1704
Pollutant: Pathogens as indicated by *Escherichia coli*

Total Maximum Daily Load (TMDL)
for
Fee Fee Creek (new)
St. Louis County

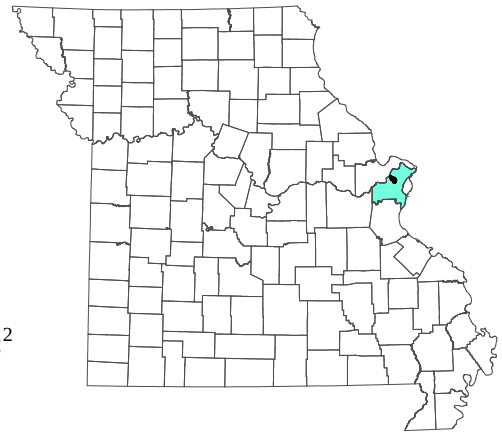
Pollutants of concern: Pathogens

Submitted: September 14, 2020
Approved: October 14, 2020

Prepared by: Water Protection Program, Watershed Protection Section

WATER BODY SUMMARY
Total Maximum Daily Load (TMDL) for Fee Fee Creek (new)
Pollutant: Pathogens as indicated by *Escherichia coli (E. coli)*

Name: Fee Fee Creek (new)



Location: St. Louis County near Maryland Heights

8-digit Hydrologic Unit Code (HUC):[1]
HUC 10300200 – Lower Missouri Subbasin

12-digit HUC Subwatershed:
HUC 103002000703 – Creve Coeur Creek

Water Body Identification Number and Hydrologic Class:[2]
Water body identification 1704 – Class P

Designated uses:[3]
Whole body contact recreation category B
Secondary contact recreation
Warm water habitat (aquatic life)
Human health protection
Livestock and wildlife protection
Irrigation

Impaired Uses:
Whole body contact recreation category B
Secondary contact recreation

Pollutant Identified on the 2018 303(d) List:
E. coli (fecal indicator bacteria)

Length and Locations of Impaired Segment:
1.5 mi (2.4 km), from mouth to Sur 992, Township 46N, Range 5E

[1] The U.S. Geological Survey delineates watersheds using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS 2013; NRCS 2013). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

[2] For hydrologic classes see 10 CSR 20-7.031(1)(F). Class P streams maintain permanent flow even in drought periods.

[3] For designated uses see 10 CSR 20-7.031(1)(C) and 10 CSR 20-7.031 Table H. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

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1. Introduction

The Missouri Department of Natural Resources, in accordance with Section 303(d) of the federal Clean Water Act, is establishing this Fee Fee Creek (new) total maximum daily load (TMDL). This TMDL report addresses a "water quality limited segment" that was approved by the U.S. Environmental Protection Agency (EPA) for inclusion on Missouri's 2018 303(d) List of impaired waters on August 30, 2019.[4] Data analyses conducted at the time of listing indicated that *E. coli* concentrations exceed Missouri's water quality criteria for the whole body contact recreation category B and secondary contact recreation designated uses. Due to new data showing attainment of the secondary contact recreational use, the Department has proposed delisting of that use's impairment from the 2020 303(d) List. The 2020 303(d) List was submitted to EPA on June 26, 2020, and at the time of this writing has not yet been approved. This report addresses the pathogen impairment of Fee Fee Creek (new) by establishing a TMDL for *E. coli* that is protective of both the applicable whole body and secondary contact recreational uses.

Section 303(d) of the federal Clean Water Act and Chapter 40 of the Code of Federal Regulations (CFR) Part 130 require states to develop TMDLs for waters not meeting applicable water quality standards. Missouri's Water Quality Standards at Title 10 of the Code of State Regulations (CSR) Division 20 Chapter 7.031 consist of three major components: designated uses, water quality criteria to protect those uses, and an antidegradation policy. The purpose of a TMDL is to determine the loading capacity of a specific pollutant that a water body can assimilate without exceeding the water quality standards for that water body. The TMDL process quantitatively assesses impairment factors so that water quality-based controls can be established to reduce pollution and restore and protect the quality of Missouri's water resources. Based on the relationship between pollutant sources and in-stream water quality conditions, a TMDL is the sum of a wasteload allocation, a load allocation (40 CFR 130.2), and a margin of safety (federal Clean Water Act section 303(d)(1)(c)). The wasteload allocation is the fraction of the loading capacity apportioned to existing or future point sources. The load allocation is the fraction of the loading capacity apportioned to existing or future nonpoint sources and natural background. The margin of safety is a portion of the TMDL that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality (40 CFR 130.7), any uncertainty associated with the model assumptions, and data inadequacies.

In addition to *E. coli*, Fee Fee Creek (new) is also listed as impaired by chloride. A separate TMDL report will be developed in the future to address this pollutant. The Department includes its TMDL prioritization and development schedule as part of the Missouri 303(d) List of impaired waters available online at dnr.mo.gov/env/wpp/waterquality/303d/303d.htm. Additional information regarding the scheduling and prioritization of TMDLs is available on the Department's TMDL webpage at dnr.mo.gov/env/wpp/tmdl/index.html.

2. Watershed Description

Fee Fee Creek (new) is a class P, urban stream located in eastern Missouri within St. Louis County and flows into Creve Coeur Creek, approximately 0.9 miles upstream from where Creve Coeur Creek empties into the Missouri River. The Fee Fee Creek (new) watershed drains approximately

[4] A water quality limited segment is any segment where it is known that water quality does not meet applicable water quality standards, or is not expected to meet applicable water quality standards, even after the application of the technology-based effluent limitations required by sections 301(b) and 306 of the federal Clean Water Act (40 CFR 130.2).

18.6 mi^2 (48.2 km^2) and encompasses a large portion of the City of Maryland Heights. The lower 17 percent (8.15 km^2) of the watershed resides in the Missouri River 500-year floodplain, which is less developed. The Missouri Use Designation Dataset identifies a 1.5 mile (2.4 kilometer) length of Fee Fee Creek (new) as water body identification number (WBID) 1704.[5] The segment extends from the confluence with Creve Coeur Creek to approximately 0.1 miles (0.1609 km) east of Vigus Road. Beginning approximately 1 mile (1.6 km) upstream of WBID 1704 Fee Fee Creek is designated a Metropolitan No-Discharge stream at 10 CSR 20-7.031 Table F. For Metropolitan No-Discharge streams, no water contaminant except uncontaminated cooling water, permitted stormwater discharges, and excess wet-weather bypass discharges that do not interfere with beneficial uses, may be discharged in the watershed. Figure 1 presents a map showing the location of the impaired water body and its watershed.

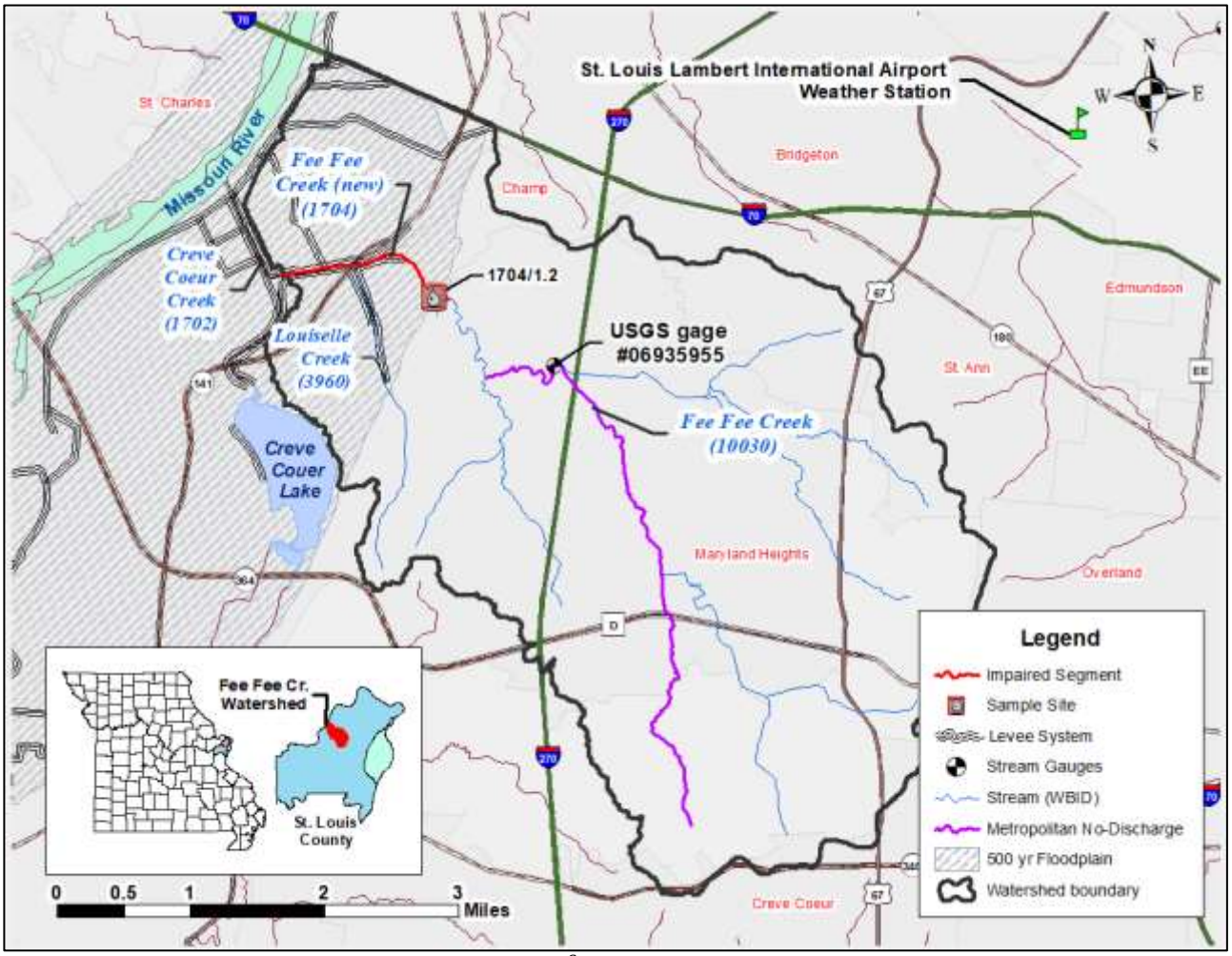

Figure 1. The Fee Fee Creek (new) watershed[6]

[5] The Missouri Use Designation Dataset documents the names and locations of the state's rivers, streams, lakes and reservoirs, and designated uses. See 10 CSR 20-7.031 (1)(P).

[6] Monitoring sites from downstream to upstream (northwest to southeast): 1) Sample site 1704/1.2 – 1.2 miles upstream on Fee Fee Creek, at Creve Coeur Mill Road., 2) USGS gage 06935355 – 3.1 miles upstream of Creve Coeur Creek, on left abutment of old bridge at McKelvey Road.

2.1 Geology, Physiography and Soils

The Fee Fee Creek (new) watershed is an area within the larger Lower Missouri subbasin identified by the 8-digit hydrologic unit code (HUC) 10300200. The Lower Missouri subbasin encompasses the lower portion of the Missouri River before it converges with the Mississippi River and lies within the eastern half of the Moreau/Loutre ecological drainage unit (MoRAP 2005). Ecological drainage units are empirically derived to represent groups of watersheds with similar biota, geography and climate characteristics (USGS 2009). The Moreau/Loutre lies in east central Missouri. The drainage unit contains over 13,000 km of stream channel, with the average stream gradient of 53.3 ft/mi (10.1 m/km). Aquatic life found in this drainage unit is generally defined as a minnow, sunfish, and sucker assemblage (MoRAP 2006).

Ecoregions represent areas with similar ecosystems and environmental resources.[7] North America is broadly divided into fifteen level I ecoregions, but contain more defined groups at lower classification levels (i.e.. level III and level IV). Within the greater Interior River Valleys and Hills ecoregion (level III), the Fee Fee Creek (new) watershed is contained within the River Hills ecoregion (level IV), a transition zone between the loess-hills and till-covered Central Irregular Plains and the rocky, dissected Ozark Highlands regions. Key features of the River Hills ecoregion include smooth to moderately dissected, forested river side-slopes and bluffs, some loess-covered hills and numerous karst features (Chapman et al. 2002). However, there are no reported karst features within the Fee Fee Creek (new) watershed.

Soils in the Fee Fee Creek (new) watershed vary in characteristics with proximity to the flood plain, landscape position, and elevation. The highest points along the ridges of the watershed are at 720 ft (220 m) in elevation and are in close proximity to tributary and Fee Fee Creek (new) headwaters where steeper hillslopes create a greater relief. Soils formed on ridges and backslopes developed from loess and are silt loam in texture. Most of the drainage area for Fee Fee Creek (new) and the lower reaches of associated tributaries are at lower elevations, ranging from 450 ft (137 m) to 480 ft (146 m). These areas have adjacent landscape ranges from 0 to 5 percent slope, the lowest portion of the watershed lies within Missouri River flood plain at 440 ft (134 m). The alluvial soils of the flood plain and the drainage ways, where flooding is frequent or occasional, make up a mosaic of soils where soil textures greatly range in proportion of fine sands and clays.

Hydrologic soil groups categorize soils by their runoff potential under thoroughly wetted, bare soil surface conditions. The Natural Resource Conservation Service bases a soil's hydrologic soil group on the rate at which water moves through the least transmissive layer, the depth to a water impermeable layer, and the depth to a high water table. Group A represents soils with the highest rate of infiltration and the lowest runoff potential under these conditions, while Group D represents soils with the lowest rate of infiltration and highest potential for runoff. In cases where a dual group is assigned, soils are considered as Group D but have the potential for improved infiltration and reduced runoff with management, as indicated by the first letter of the dual group. Since the hydrologic soil group categorization is based on a soil's natural characteristics if it were undisturbed, soils disturbed by construction and other management activities have altered hydrologic properties and are categorized as not rated (NRCS 2009).

[7] Ecoregion is defined in Missouri's Water Quality Standards at 10 CSR 20-7.031 (1)(H).

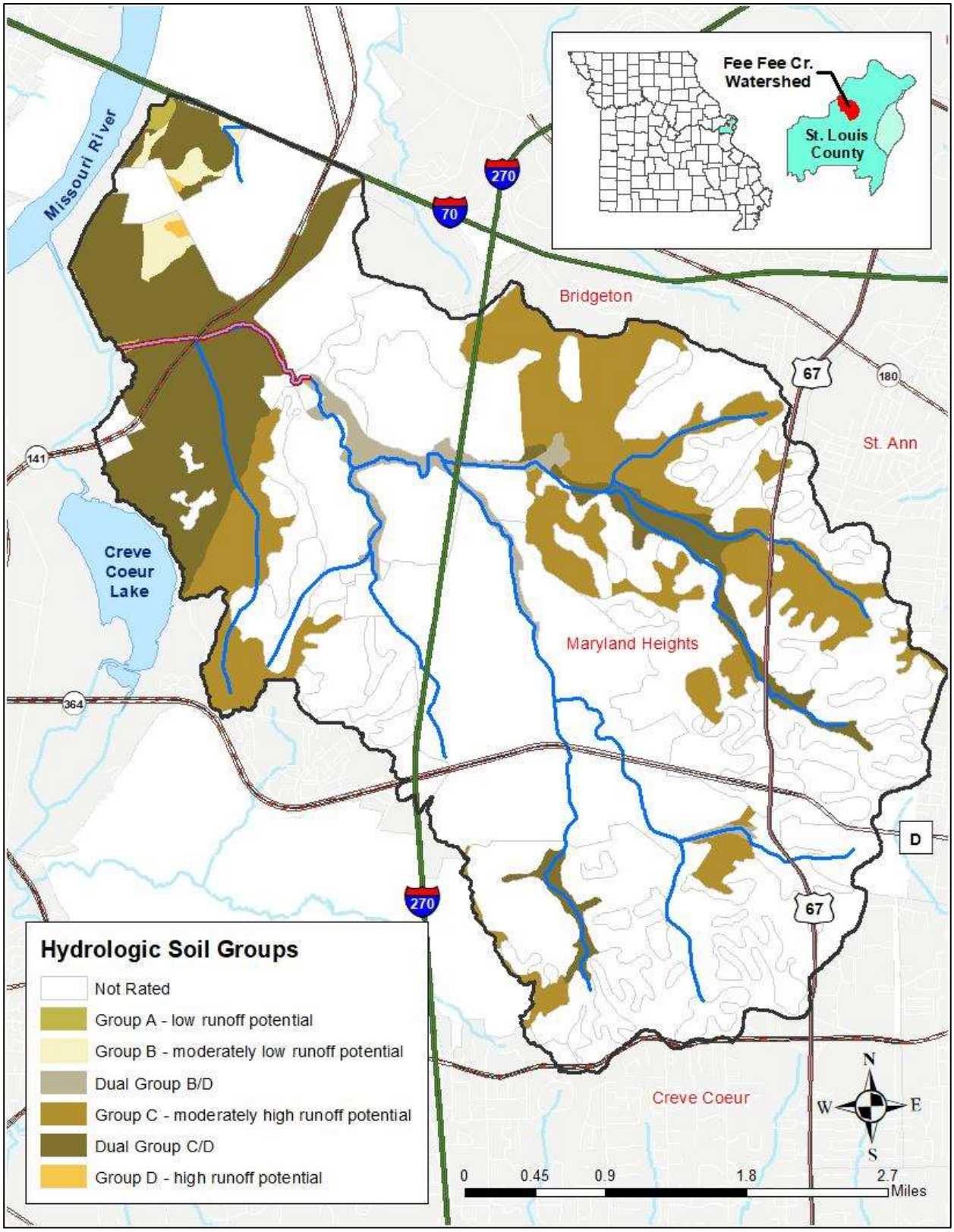

Figure 2. Hydrologic soil groups in the Fee Fee Creek (new) watershed (NRCS 2011*)*

The Fee Fee Creek (new) watershed (Table 1) has great potential for poor infiltration and increased runoff. Approximately 70 percent of the watershed is designated as Not Rated, which includes a small portion of areas with open water (0.2 percent), quarries (2 percent), and where areas are greater than 90 percent urban land (NRCS 2010). Areal imagery of the watershed taken after the most recently updated Soil Survey report (NRCS 2011) shows increased development in the watershed (MSDIS/NAIP 2014). A present-day assessment would likely show a greater percent of the watershed's hydrologic soil groups designated as not rated due to disturbance. As it stands, Group A and B soils, occurring only in the flood plain, make up 0.22 and 0.86 percent of the area, respectively, and have high infiltration rates due to fine sand and silt loam surface textures. Group C soils with moderately high runoff potential are found mostly on hillslopes, cover approximately 13.6 percent of the watershed, and consist of silt loam and silty clay loam soils. Group D soils have poor infiltration and high runoff potential due to clayey soils that slow down water infiltration. In the Fee Fee Creek (new) watershed, group D soils only represent 0.11 percent of the area and are located solely in the Missouri River flood plain. Dual groups B/D and C/D, which encompass 1.83 and 13.0 percent of the watershed, have characteristics of Groups B and C but also have a high water table typical of Group D soils. These soils are either adjacent to Fee Fee Creek (new) in the floodplain and lower portions of the drainage ways or higher in the landscape along some sections of tributaries. A significant portion of soils in the Fee Fee Creek (new) watershed are not rated. These areas are primarily urban development and impervious surfaces overlying Harvester complex soil groups. Infiltration rates in these areas are expected to be poor and runoff potential high.

Overall, soil characteristics are only one factor influencing runoff in the watershed. Impervious surfaces, vegetative cover, slope, rainfall intensity and land use additionally influence the potential for runoff.

Table 1. Hydrologic soil groups in the Fee Fee Creek (new) watershed (NRCS 2011)

Hydrologic Soil Group	Area (mi^2)	Area (km^2)	Area (acres)	Area (%)
Group A	0.04	0.11	25.6	0.22
Group B	0.16	0.41	102.4	0.86
Dual Group B/D	0.34	0.89	217.6	1.83
Group C	2.52	6.52	1612.8	13.55
Dual Group C/D	2.41	6.25	1542.4	12.96
Group D	0.02	0.05	12.8	0.11
Not Rated	13.11	33.95	8390.4	70.48
Totals:	**18.60**	**48.18**	**11,904.0**	**100.00**

2.2 Rainfall and Climate

Weather stations provide useful information for developing a general understanding of climatic conditions in a watershed. The St. Louis Lambert International Airport weather station is the closest source of available weather and climate data to the Fee Fee Creek (new) watershed (NOAA 2019). Climate normals are three-decade averages of climatological variables, including temperature and precipitation, produced by the National Centers for Environmental Information every 10 years

(NOAA 2019). The monthly precipitation and temperature normals calculated from this station are derived from weather data collected during the 30-year period of 1981 through 2010. Of the various climatic factors, precipitation is especially important as it is related to stream flow and runoff events that can influence certain pollutant sources. Figure 1 shows the location of the St. Louis Lambert International Airport weather station in relation to the Fee Fee Creek (new) watershed. Table 2 presents the 30-year monthly climate normal from the St. Louis Lambert International Airport weather station for both temperature (temp) and precipitation (PPTN). Figures 3 and 4 further summarize these data.

Table 2. 30-year monthly climate normal at the St. Louis Lambert International Airport

Month	Total PPTN in (mm)	Mean Maximum Temp ºF (ºC)	Mean Minimum Temp ºF (ºC)
January	2.4 (61.0)	39.9 (4.4)	23.7 (-4.6)
February	2.2 (56.9)	45.0 (7.2)	27.6 (-2.4)
March	3.3 (84.3)	55.9 (13.3)	36.6 (2.6)
April	3.7 (93.7)	67.4 (19.7)	47.2 (8.4)
May	4.7 (119.9)	76.3 (24.6)	57.2 (14)
June	4.3 (108.7)	85.1 (29.5)	66.8 (19.3)
July	4.1 (104.4)	89.1 (31.7)	71.0 (21.7)
August	3.0 (75.9)	87.9 (31.1)	69.4 (20.8)
September	3.1 (79.5)	80.2 (26.8)	60.6 (15.9)
October	3.3 (84.6)	68.5 (20.3)	49.0 (9.4)
November	3.9 (99.3)	55.5 (13.1)	38.1 (3.39)
December	2.8 (72.1)	42.5 (5.8)	26.9 (-2.8)
Total PPTN & Avg Temp*:*	41.0 (89.0)	66.1 (18.9)	47.8 (8.8)

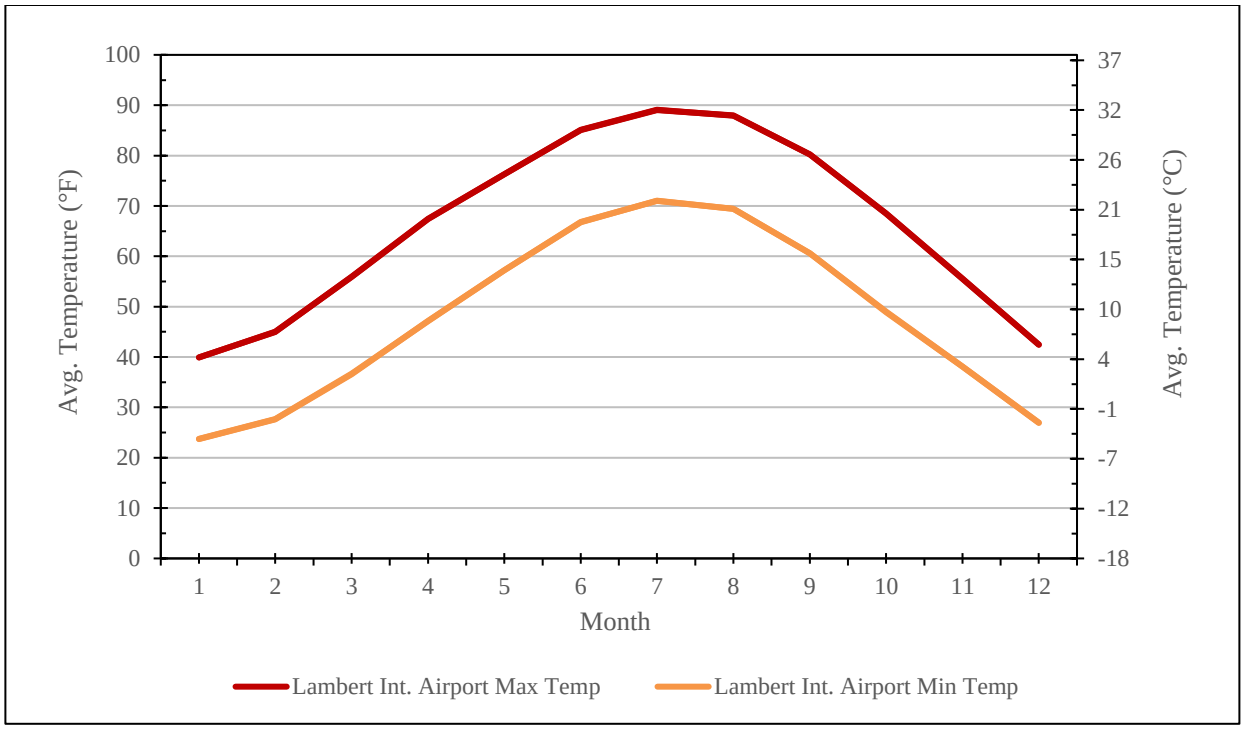

Figure 3. Monthly minimum and maximum temperature normals

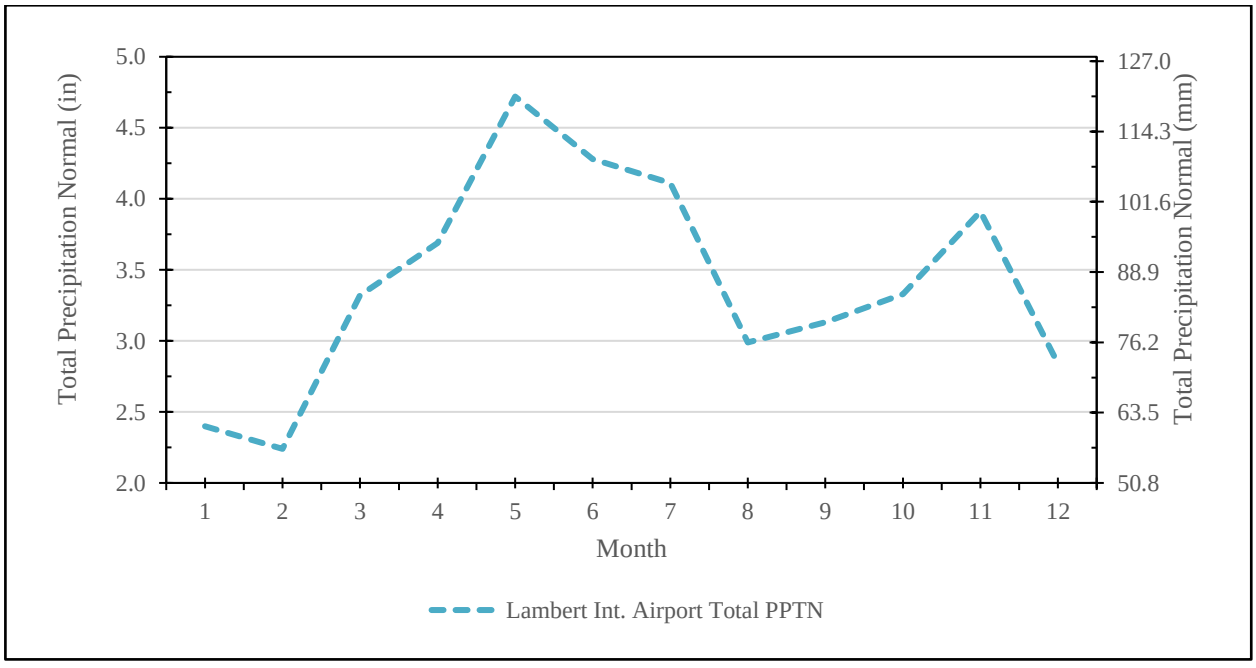

Figure 4. Monthly precipitation normals

2.3 Population

State and county population estimates are readily available from the U.S. Census Bureau's 2010 census. St. Louis County covers an area of 523 mi^2 (1,355 km^2) and, according to 2010 census data, has a population of 999,021 people. Using U.S. Census Bureau census block data from 2010, the population of the Fee Fee Creek watershed is estimated to be approximately 43,556. This

estimation method uses Geographic Information System (GIS) software and superimposes the watershed boundary over a map of census blocks (Figure 5). Where the centroid of a census block falls within the watershed boundary, its total population was included in the grand total for the watershed. If the centroid of the census block is outside the watershed boundary, then the population is excluded. Approximately 90 percent of the watershed is contained within a U.S. Census Bureau defined urban area.[8] EPA defines urban areas as entities requiring stormwater regulations through municipal separate storm sewer permits (EPA 2014a).

EPA completed a separate population analysis at the 12-digit HUC subwatersheds level for purposes unrelated to this TMDL. They used demographic and census block data and a web-based tool called EJSCREEN to determine areas of the state having potential Environmental Justice concerns. EPA defines Environmental Justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies (EPA 2014b). Environmental Justice communities may qualify for financial and strategic assistance for addressing environmental and public health issues (EPA 2011a). From this analysis, EPA determined that the Fee Fee Creek (new) watershed has potential Environmental Justice concerns for approximately 5 to 15 percent of the area.

[8] An urban area is delineated by the U.S. Census Bureau to represent densely populated areas (https://www.census.gov/geo/reference/ua/urban-rural-2010.html)

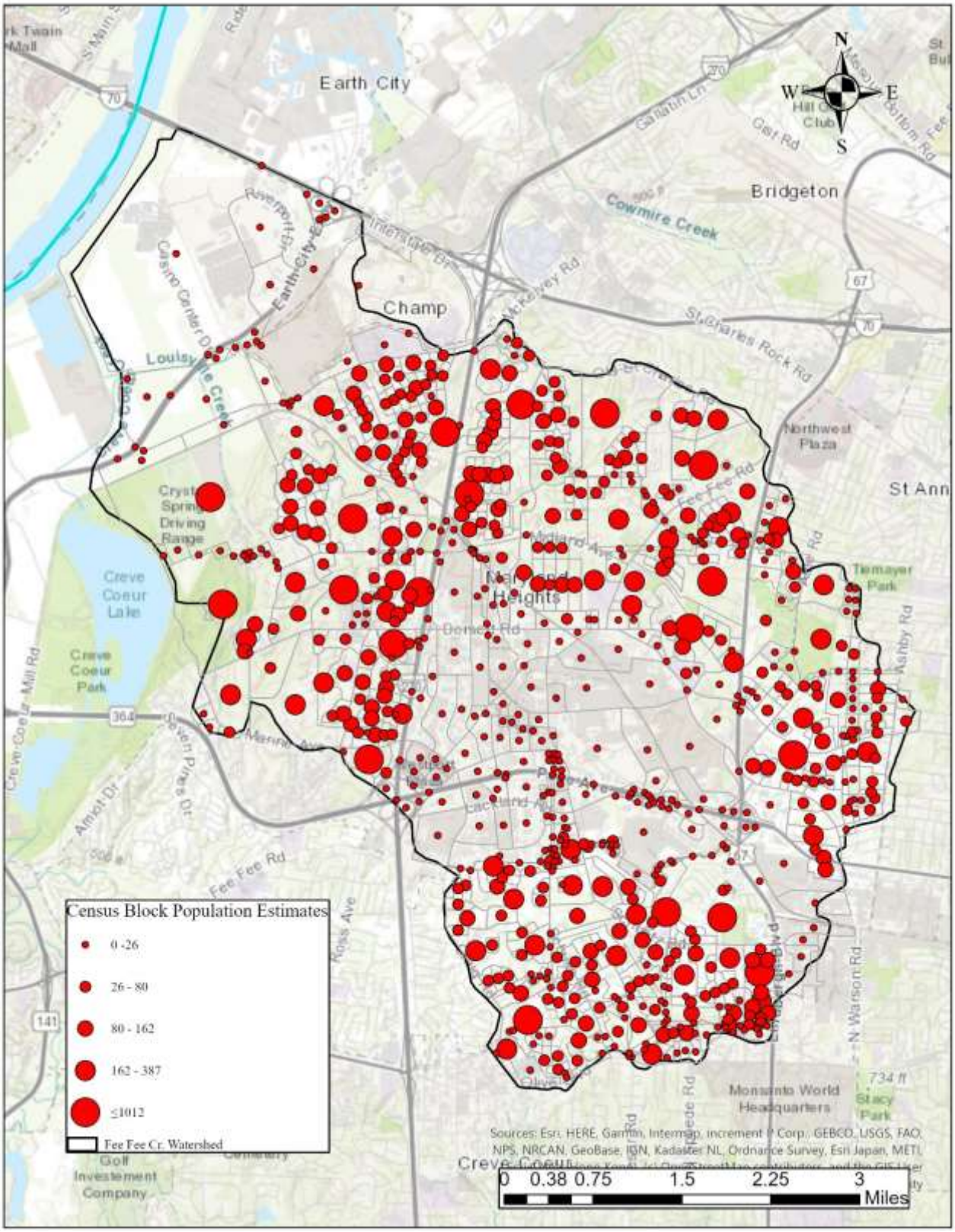

Figure 5. Fee Fee Creek watershed census block population distribution.

2.4 Land Cover

A land cover distribution map (Figure 6) and calculations (Table 3) for Fee Fee Creek (new) watershed were made using the 2011 National Land Cover Database published by the U.S. Geological Survey (USGS) (Homer et al. 2015). From this information, the watershed is approximately 88 percent developed. Around 7.7 mi^2 is under low intensity development, defined as having 20 to 49 percent impervious cover and composed primarily of single-family housing units. Areas of medium intensity development compose around 3.7 mi^2 of the watershed and also consist primarily of single-family housing units, but contain from 50 to 79 percent impervious cover. Approximately 2 mi^2 of the watershed area is under high intensity development, where impervious cover is 80 to 100 percent. This amount of imperviousness in the Fee Fee Creek (new) watershed is significant, because stream degradation associated with imperviousness begins at about 10 percent of imperviousness and increases in severity as imperviousness increases (Arnold and Gibbons 1996; Schueler 1994). Areas of less imperviousness are also located in the watershed but are still associated with some degree of development. Approximately 3 mi^2 is developed open space, which is composed primarily of lawn grasses such as those found in parks, yards, and golf courses or planted for erosion control and aesthetic purposes. Impervious surfaces in these open space areas are still common, but account for less than 20 percent of the cover. More pervious areas in the watershed include less than 1 mi^2 of forest cover, 0.03 mi^2 of shrub and herbaceous cover, 0.06 mi^2 under hay or pasture, and 0.24 mi^2 of land considered as wetlands.

Table 3. Land cover in the Fee Fee Creek (new) watershed

Land Cover	Area				
	acres	(hectares)	mi^2	(km^2)	Percentage
Developed, High Intensity	1,245.0	(503.8)	1.95	(5.04)	10.5
Developed, Medium Intensity	2,333.4	(944.3)	3.65	(9.44)	19.6
Developed, Low Intensity	4,954.3	(2,004.9)	7.74	(20.05)	41.6
Developed, Open Space	1,917.7	(776.1)	3.00	(7.76)	16.1
Forest	552.9	(223.7)	0.86	(2.24)	4.6
Shrub and Herbaceous	21.3	(8.6)	0.03	(0.09)	0.2
Hay/Pasture	35.6	(14.4)	0.06	(0.14)	0.3
Cultivated Crops	651.2	(263.5)	1.02	(2.64)	5.5
Barren Land	16.9	(6.8)	0.03	(0.07)	0.1
Open Water	18.2	(7.4)	0.03	(0.07)	0.2
Wetlands	154.1	(62.4)	0.24	(0.62)	1.3
Total:	**11,900.6**	**(4,816.0)**	**18.59**	**(48.16)**	**100**

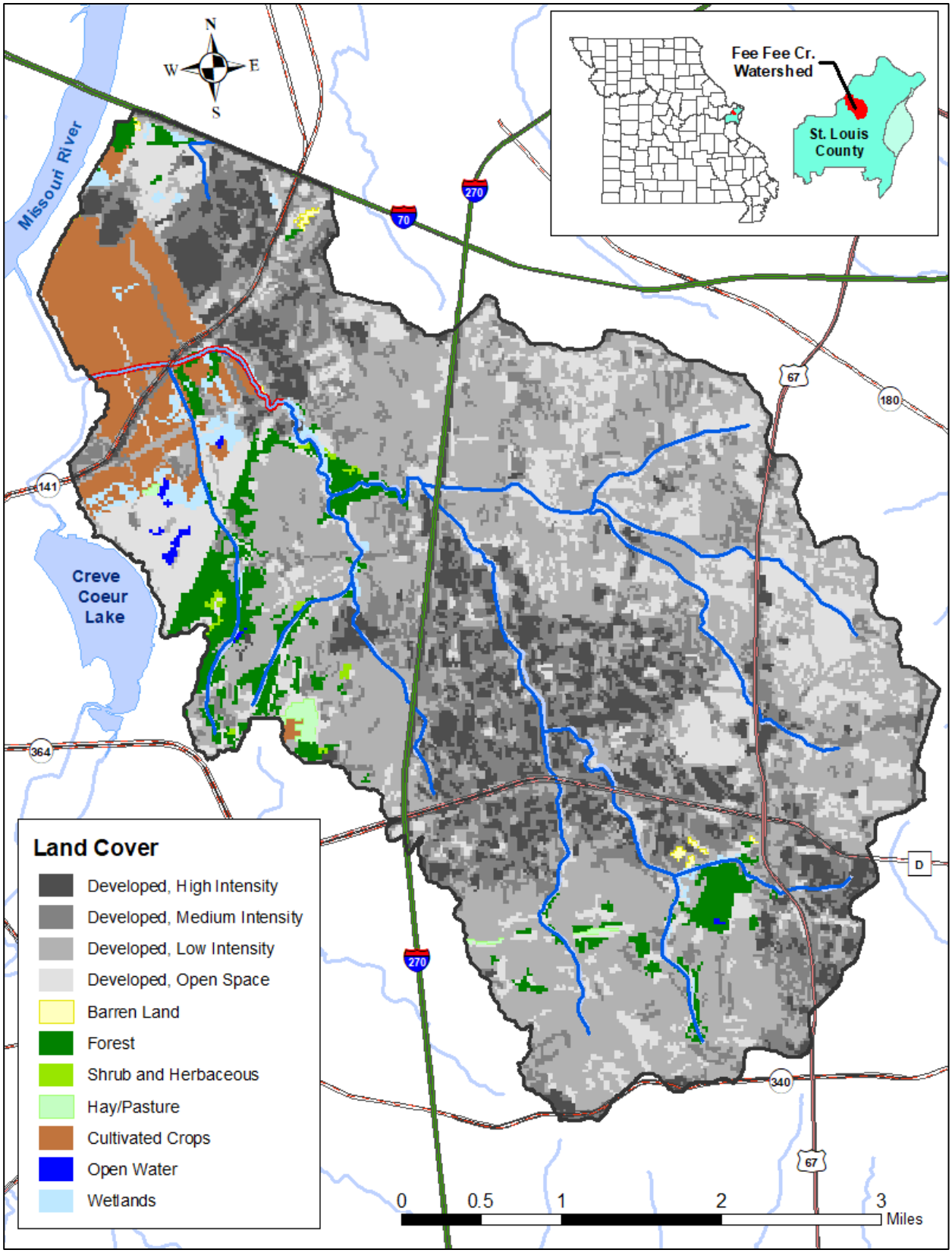

Figure 6. Land cover in the Fee Fee Creek (new) watershed.

3. Applicable Water Quality Standards

The purpose of developing a TMDL is to identify the pollutant loading a water body can assimilate and still attain water quality standards. Water quality standards are therefore central to the TMDL development process. Under the federal Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters (U.S. Code Title 33, Chapter 26, Subchapter III). Water quality standards consist of three major components: designated uses, water quality criteria, and an antidegradation policy.

Per federal regulations at 40 CFR 131.10, the designated uses and criteria to protect those uses assigned to a water body shall provide for the attainment and maintenance of the water quality standards of downstream waters. Missouri's general criteria at 10 CSR 20-7.031(4)(E) also require that the water quality at the confluence to downstream waters provides for the attainment and maintenance of downstream water quality standards. The components of Missouri's Water Quality Standards discussed in this section meet these requirements and are approved by the EPA. It is not the purview of a TMDL to revise existing water quality standards. In the event that future water quality monitoring demonstrates that water quality standards are not protective of downstream uses, EPA's Water Quality Handbook describes how to address the situation under the federal Clean Water Act.[9]

3.1 Designated Uses

Designated uses are the uses for a water body defined in the state Water Quality Standards at 10 CSR 20-7.031(1)(C) and assigned per 10 CSR 20-7.031(2) and Table H.[10] These uses must be maintained in accordance with the federal Clean Water Act. The following designated uses have been assigned to Fee Fee Creek (new) and are reflected in the Missouri Use Designation Dataset as described in 10 CSR 20-7.031(2)(E):

- Livestock and wildlife protection;
- Irrigation;
- Warm water habitat (aquatic life);
- Human health protection;
- Whole body contact recreation category B; and
- Secondary Contact Recreation.

For Fee Fee Creek (new), the whole body contact recreation category B and secondary contact recreation uses are listed as impaired due to high *E. coli* concentrations. Whole body contact recreation includes activities involving direct human contact with waters of the state to the point of complete body submergence (10 CSR 20-7.031(1)(C)2.A.). During these activities, such as swimming, accidental ingestion of the water may occur and there is direct contact to sensitive body organs, such as the eyes, ears, and nose. Category A waters include water bodies established by the property owner as public swimming areas and waters with documented existing whole body contact recreational uses by the public (10 CSR 20-7.031(1)(C)2.A.(I)). Category B applies to waters designated for whole body contact recreation, but are not contained within category A (10 CSR

[9] https://www.epa.gov/wqs-tech/water-quality-standards-handbook

[10] The terminology used for naming designated uses varies from what is presented in the text of 10 CSR 20-7.031 and what is presented in Table H. The terminology utilized in the text of the water quality standards rule is presented here.

20-7.031(1)(C)2.A.(II)). Secondary contact recreation includes activities, such as boating, fishing and wading, in which there is limited, incidental or accidental contact with the water and the probability of ingesting appreciable quantities of water is minimal (10 CSR 20-7.031(1)(C)2.B.).

3.2 Water Quality Criteria

Water quality criteria are limits on certain chemicals or conditions in a water body to protect particular designated uses. Criteria are expressed as specific numeric criteria or as general narrative statements. In Missouri's Water Quality Standards at 10 CSR 20-7.031(5)(C) and Table A1, specific numeric criteria are given for the protection of the whole body contact recreation use. For category B waters, *E. coli* counts, measured as a geometric mean, shall not exceed 206 counts/100 mL of water during the recreational season. This criterion is also protective of the secondary contact recreation designated use. The *E. coli* criterion for the protection of secondary contact recreation is a geometric mean concentration that does not exceed 1,134 counts/100 mL of water during the recreational season. The state's recreational season defined in this section of the rule is from April 1 to October 31.

3.3 Antidegradation Policy

Missouri's Water Quality Standards include the EPA "three-tiered" approach to antidegradation, and may be found at 10 CSR 20-7.031(3).

Tier 1 – Protects public health, existing instream water uses, and a level of water quality necessary to maintain and protect existing uses. Tier 1 provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses attained on or after Nov. 28, 1975, the date of EPA's first Water Quality Standards Regulation.

Tier 2 – Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economic and social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national and state resource waters, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

Waters in which a pollutant is at, near, or exceeds the water quality criteria are considered in Tier 1 status for that pollutant. Therefore, the antidegradation goals for Fee Fee Creek (new) are to restore water quality to levels that meet water quality standards.

4. Defining the Problem

The Department assesses a stream to be impaired for *E. coli* if the water quality criteria are exceeded in any of the last three years for which there is a minimum of five samples collected during the recreational season. This approach is detailed in the Department's 2018 Listing Methodology Document, which is available online at dnr.mo.gov/env/wpp/waterquality/303d/303d.htm. Per federal regulations at 40 CFR§130.7(c)(1), TMDLs are required for all waters included on a state's approved 303(d) list.

Recreational season *E. coli* bacteria data collected from Fee Fee Creek (new) from 2014 to 2019 are summarized in Table 4. Individual bacteria measurements collected during this period are presented in Appendix A. Observed *E. coli* measurements presented here are for illustration purposes only and were not used in the calculation of the TMDL loading capacity or allocations. Observed data may be used to estimate pollutant reduction targets for targeting implementation activities and selecting appropriate best management practices. Reduction targets for Fee Fee Creek (new) are presented in a supplemental TMDL implementation strategies document available online at dnr.mo.gov/env/wpp/tmdl/1704-fee-fee-creek-record.htm. It should be noted current monitoring data indicates Fee Fee Creek (new) is attaining the secondary contact recreational use and impairment of this use has been proposed for removal from the 2020 303(d) listing pending EPA final approval.

Table 4. Recreational season *E. coli* data (2014 – 2019)

Water Body ID	Year	Number of Samples	Geometric Mean* (counts/100mL)	Minimum (count/100mL)	Maximum (count/100mL)
1704	2014	7	1,784.14	120	> 24,196
	2015	5	284.48	86	960
	2016	6	979.98	75	13,000
	2017	7	112.69	5	6,100
	2018	7	688.47	41	> 24,196
	2019	5	384.11	170	1,800

* When calculating geometric means, values reported as greater-than (>) were doubled and less-than (<) were halved. This is consistent with the Department's assessment procedures described in the 2018 Listing Methodology Document.

5. Source Inventory and Assessment

Various sources may be contributing bacteria loads to the impaired water body. For this reason, a source inventory and assessment is included in this TMDL report to identify and characterize known, suspected, and potential sources of pollutant loading within the Fee Fee Creek (new) watershed. The potential sources of bacteria loading identified in this TMDL report are categorized and quantified to the extent that information is available. These sources are categorized as being either point (regulated) or nonpoint (unregulated).

5.1 Point Sources

Point sources are defined under Section 502(14) of the federal Clean Water Act and are typically regulated through the Missouri State Operating Permit program.[11] Point sources include any discernible, confined, and discrete conveyance, such as a pipe, ditch, channel, tunnel, or conduit, by which pollutants are transported to a water body. Under this definition, point sources include permitted municipal and domestic wastewater dischargers, site-specific permitted industrial and non-domestic wastewater dischargers, concentrated animal feeding operations, municipal separate storm sewer systems, and general and stormwater permitted entites. In addition to these permitted sources, illicit straight pipe discharges, which are illegal and therefore unpermitted, are also considered point sources.

At the time of this writing, the Fee Fee Creek (new) watershed contains 36 permitted entities. Of these 36 permits, one is a site-specicific permit for process wastewater, stormwater, and groundwater discharge from a sanitary and industrial landfill, two are regulated municipal separate storm sewer systems (MS4), two are general wastewater permits, and the remaining 31 are non-MS4 stormwater permits. There are no facilities with municipal and domestic wastewater permits in the Fee Fee Creek (new) watershed, nor are there any permitted CAFOs. Figure 7 shows the location of point source outfalls within the Fee Fee Creek (new) watershed. Multiple outfalls for the same facility are covered under one permit.

5.1.1 Municipal and Domestic Wastewater Permits

Domestic wastewater dischargers include both municipal and non-municipal wastewater treatment facilities. Domestic wastewater is primarily household waste, which includes graywater and sewage. Untreated or inadequately treated discharges of domestic wastewater can be significant sources of bacteria to receiving waters (EPA 1986). However, there are no municipal or other domestic wastewater permitted discharges in the Fee Fee Creek (new) watershed. The Metropolitan St. Louis Sewer District operates and maintains a sanitary sewer system throughout the watershed. The Missouri River Wastewater Treatment Plant (permit MO-0004391) is located outside of the watershed and collects all the domestic wastewater that originates from the Fee Fee Creek (new) watershed. The sewage collection and transport system infrastructure within the Fee Fee Creek (new) watershed is a potential source of bacteria due to possible breakage or overflows.

[11] The Missouri State Operating Permit system is Missouri's program for administering the federal National Pollutant Discharge Elimination System (NPDES) program. The NPDES program requires all point sources that discharge pollutants to waters of the United States to obtain a permit.

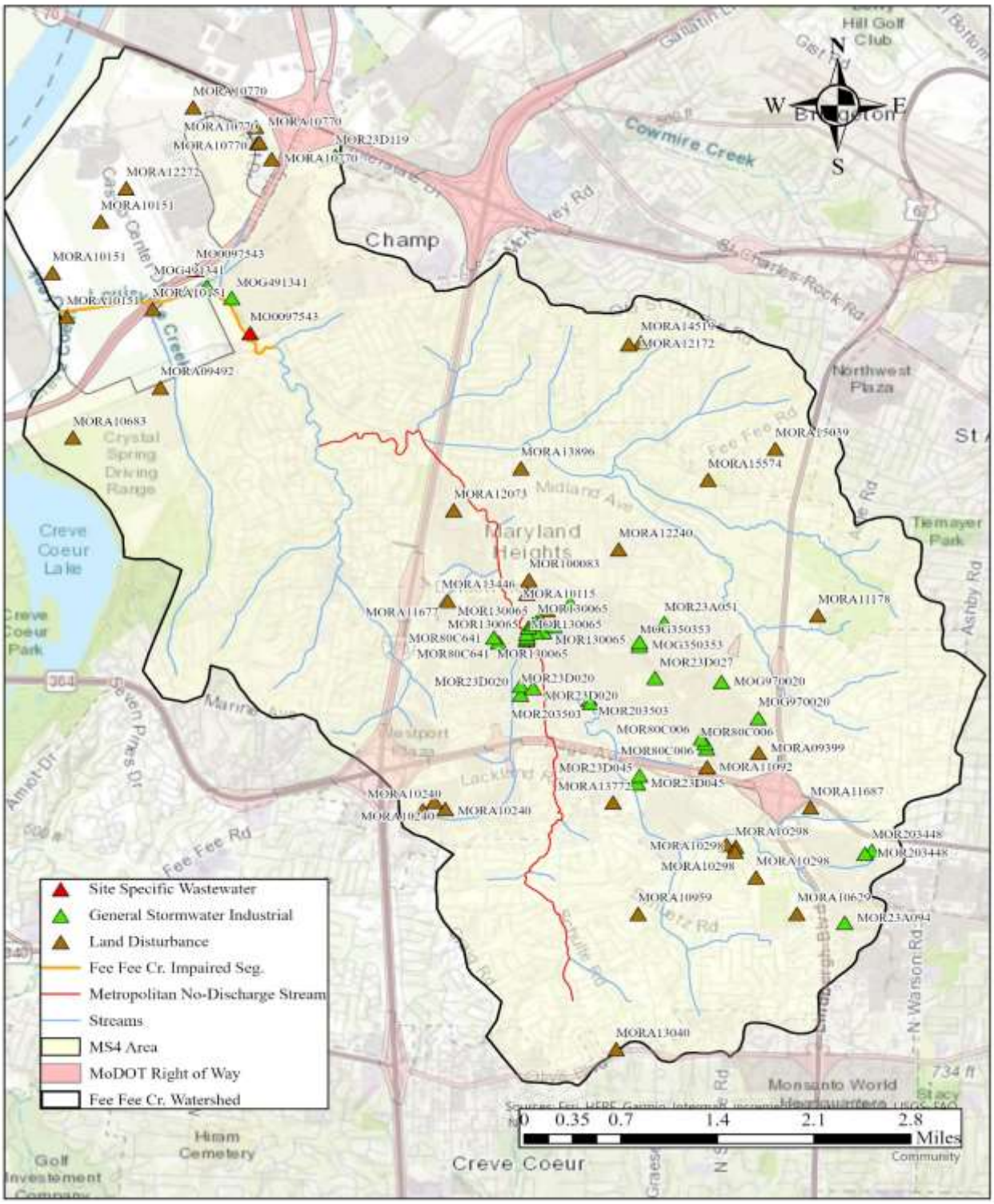

Figure 7. Point Source outfall locations in the Fee Fee Creek (new) watershed[12]

[12] Two MS4 permits regulate discharges of stormwater runoff throughout much of the watershed area. Permit MO-0137910 regulates stormwater discharges from Missouri Department of Transportation right-of-ways and permit MO-R040005 regulates MS4 stormwater discharges from the Metropolitan St. Louis Sewer District and its co-permitees.

Sanitary sewer overflows (SSOs) are untreated or partially treated sewage releases from a sanitary sewer system. Overflows could occur for a variety of reasons including blockages, line breaks, sewer defects, power failures and vandalism. Sanitary sewer overflows can occur during either dry or wet weather and at any point in the collection system, including manholes. Such overflows are unauthorized by the federal Clean Water Act. Occurrences of sanitary sewer overflows can result in elevated bacteria concentrations (EPA 1996). During the period of January 2012 through February 2019, MSD reported 40 sanitary sewer overflows in the Fee Fee Creek (new) watershed to the Department. However, some overflows discharged to dry land or were otherwise contained and did not reach a water body.

In addition to SSO events, constructed SSOs, which were designed to relieve the sanitary sewer system during heavy rainstorms when storm water infiltrates the system, are also contributors of *E. coli* in the Fee Fee Creek (new) watershed. A USGS study on sources of *E. coli* in metropolitan St. Louis area streams noted a correlation between *E. coli* densities and the number of upstream SSOs and reported that at least one-third of the measured in-stream *E. coli* from the sampled streams originated from humans (USGS 2010).[13] Required implementation actions to address constructed SSOs should be conducted in accordance with the consent decree established as part of the *United States of America and the State of Missouri, and Missouri Coalition for the Environment Foundation v. Metropolitan St. Louis Sewer District*, No. 4:07-CV-1120. Constructed SSOs are considered a substantial contributor of bacteria and cause of impairment to Fee Fee Creek (new).

The consent decree requires the elimination of all constructed SSOs in the Metropolitan St. Louis Sewer District's service area and provides a specific timeline for such eliminations. In accordance with the consent decree, constructed sanitary sewer overflows will be scheduled for elimination by no later than 2033 with 85 percent of the overflow outfalls to be eliminated by 2023. The order of the eliminations will be based on the potential for human health and environmental risks, frequency of overflow, estimated volumes, and technical engineering judgment. A schedule for the elimination of all constructed sanitary sewer overflows in the Fee Fee Creek (new) watershed is presented in Table 5. The removal date given indicates the date after which EPA can assess penalties.

Table 5. Elimination dates of constructed SSOs in the Fee Fee Creek (new) watershed.

Name	Street Number	Street Name	Removal Date	Status
BP-067	3186	Bristol Hall	N/A*	Eliminated
BP-068	2410	Bruno	2014	Eliminated
BP-069	1217	Crested View Drive	2023	Existing
BP-071	2	Fee Fee Road	N/A*	Eliminated
BP-072	165	Forest Brook Lane	2007	Eliminated
BP-073	166	Forest Brook Lane	2007	Eliminated
BP-074	113	Willow Brook Lane	N/A*	Eliminated
BP-075	67	Graeler	2005	Eliminated
BP-076	26	Gandy Drive	2016	Eliminated
BP-077	1	Harbor Circle	2003	Eliminated

[13] This USGS study categorized samples as either human, dog, or geese when 80 percent of the genetic markers were similar. Those with a less than 80 percent match were categorized as unknown. However, those categorized as unknown may include some percentage of human, dog or geese as well as other urban wildlife (USGS 2010).

BP-078	11623	Holy Springs	2023	Existing
BP-079	1032	Leisure Lane	N/A*	Eliminated
BP-080	2466	Majorlee	2023	Eliminated
BP-081	10964	Margate Hall Drive	N/A*	Eliminated
BP-082	10687	Midland Boulevard	2002	Eliminated
BP-083	107	Midland Boulevard	2015	Eliminated
BP-084	10808	Midland Boulevard	N/A*	Eliminated
BP-085	1301	Thames Court	2007	Eliminated
BP-086	11220	Triste Drive	2018	Eliminated
BP-087	11749	Westport Crossing	2023	Existing
BP-088	12479	Roth Hill	2010	Eliminated
BP-491	11050	Galaxy Court	2014	Eliminated
BP-511	N/A	Alan Shepard WWSR Lift Station	2016	Eliminated
BP-537	2667	Adie	2013	Eliminated
BP-540	121	Brookside	2007	Eliminated
BP-549	2008	Kratky Road	1999	Eliminated
BP-642	10908	Midland	2014	Eliminated
*****Structure eliminated prior to scheduling (Source: Metropolitan St. Louis Sewer District)				

5.1.2 Site-Specific Industrial and Non-Domestic Wastewater Permits

Site-specific industrial and non-domestic wastewater permits differ from general wastewater permits by having conditions specific to a facility's site and operation. Industrial and non-domestic facilities discharge wastewater resulting from non-sewage generating activities and are typically not expected to cause or contribute to bacteria impairments.

There is one facility in the Fee Fee Creek (new) watershed with a site-specific industrial permit. IESI MO Champ landfill, permit MO-0097543, is a sanitary and industrial waste landfill having 254 acres of disposal area on 542 permitted acres, which accepts special asbestos waste, wastewater treatment plant sludge, and treated medical waste. Additional operations on the property includes Breckinridge Concrete Plant, North Stone Asphalt Plant, a compost area operated by Hansen's Tree, and a limestone quarry operated by Fred Weber, Inc.

The facility has two permitted outfalls and operates in compliance with 10 CSR 80-3.010(8), which requires the onsite drainage structures be designed to prevent flow onto the active portion of the sanitary landfill during peak discharge from at least a 25-year storm. Leachate and leachate impacted stormwater are conveyed to Metropolitan St. Louis Sewer District from on-site leachate storage ponds. Separate from the leachate, wastewater at the site from the Breckenridge concrete company is discharged from outfalls No. 011 and No. 015. These outfalls receive process wastewater from stone transfer, rock crushing, wash water from the concrete plant operations, and run off from the gravel stockpiles. One outfall on the property discharges process wastewater and stormwater from Breckinridge, North Stone's plant and quarry stockpiles, the southern portion of an inactive landfill, and from an enclosed landfill gas flare station. Stormwater and washwater associated with stone transfer, rock crushing, gravel stockpiles, capped and vegetated landfill, concrete plant operations, and heavy vehicle traffic is captured in a sedimentation basin, treated with carbon dioxide to adjust solution pH to 7.5, and precipitation driven and gravity transported

into Fee Fee Creek (new). Process wastewater, stormwater, and groundwater collected from the active landfill, a portion of the inactive landfill, the compost operation, and the North Stone quarry pit are collected into a detention/sedimentation basin. Discharge from this basin, through the second permitted outfall, is also precipitation driven and releases into an unclassified tributary of Fee Fee Creek (new). Since the leachate from the active portion of the landfill that collects domestic wastewater treatment plant sludge is not discharged, IESI MO Champ landfill is not considered a source of *E. coli*.

5.1.3 Municipal Separate Storm Sewer System (MS4) Permits

There are two MS4 permits in the Fee Fee Creek (new) watershed. One is a site-specific permit issued to the Missouri Department of Transportation (MoDOT), permit number MO-0137910, and regulates stormwater discharges from highway right-of-ways and other MoDOT owned properties. This permit is more commonly referred to as a transportation separate storm sewer system (TS4) permit. The second MS4 permit in the watershed is a general small MS4 permit, number MO-R040005, issued to the Metropolitan St. Louis Sewer District and its co-permittees. Co-permittees in the Fee Fee Creek (new) watershed include St. Louis County and the municipalities of Bridgeton, Champ, Creve Coeur, Maryland Heights, Overland, and St. Ann.

MS4 permits authorize the discharge of urban stormwater runoff. In general, urban runoff carries high levels of bacteria and may result in exceedances of water quality criteria during and immediately after storm events in most streams throughout the country (EPA 1983). Runoff contaminated with *E. coli* flows from open areas where soil erosion is common and from heavily paved areas (EPA and Pitt 2002). For these reasons, urban runoff is a potential contributor of bacteria to Fee Fee Creek (new).

Urban sourced, bacterial loading to streams can be from SSOs, as discussed in Section 5.1.1 of this document, and from residential and green space runoff carrying domestic and wild animal waste. Birds, dogs, cats, and rodents are documented as common sources of *E. coli* in urban stormwater (Burton and Pitt 2002). Another source of urban stormwater is runoff originating from highway corridors. The Federal Highway Administration published research identifying bird droppings, soil, and vehicles carrying livestock and stockyard wastes as sources that may periodically "seed" highway corridors with *E. coli* and other pathogens. The study further notes that the magnitude of contaminated runoff from highway systems are site-specific and can be affected by numerous factors, such as traffic, design, maintenance, land use, climate, and accidental spills (FHWA 1984). For these reasons, the significance of any highway contributions of bacteria in the Fee Fee Creek (new) watershed cannot be quantified in this TMDL report. Due to the intermittent and potentially sporadic nature of highway bacterial contributions described in the federal study and to the urban nature of the watershed, which makes contributions from the transport of livestock and stockyard wastes less likely, highway systems are not expected to be a significant contributor to the bacteria impairments in the Fee Fee Creek (new) watershed. Highway systems, however, do remain a potentially significant source of heavy metals, inorganic salts, aromatic hydrocarbons, and suspended solids (FHWA 1998).

Although stormwater discharges are often untreated, MS4 permit holders must develop, implement, and enforce stormwater management plans to reduce the contamination of stormwater runoff and prohibit illicit discharges. Stormwater management plans must include measurable goals, annual reports, and six minimum control measures. These control measures include public education and

outreach, public participation and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention. MS4 permits may also require the development of supplemental TMDL Assumptions and Requirement Attainment Plans where applicable.

5.1.4 General Wastewater and Non-MS4 Stormwater Permits

General and stormwater permits are issued based on the type of activity and are meant to be flexible enough to allow for ease and speed of issuance while providing the required protection of water quality. General and stormwater permits are designated with permit numbers beginning with "MO-G" or "MO-R", respectively, and are issued for activities similar enough to be covered by a single set of requirements. A summary of the general and non-MS4 stormwater permits in the Fee Fee Creek (new) watershed, as of March 27, 2020, is presented in Table 6. Permits associated with land disturbance activities are temporary and the number of effective permits of this type in the watershed may vary in any given year. Despite this variability, TMDL calculations and targets will not change as a result of changes in the numbers of these types of permits.

The Department assumes activities authorized under these general and stormwater permits will be conducted in compliance with all permit conditions, including monitoring and discharge limitations. It is expected that compliance with these permits will protect the designated recreational use within the watershed. For these reasons, these facilities are not expected to cause or contribute to the bacterial impairment of Fee Fee Creek (new). If at any time the Department determines that the water quality of streams in the watershed is not being adequately protected, the Department may require the owner or operator of the permitted site to obtain a site-specific operating permit, per 10 CSR 20-6.010(13)(C).

Table 6. General (MO-G) and non-MS4 stormwater (MO-R) permits

Permit Number	Facility Name	Discharge Type	Permit Type	Permit Expiration
MO-R80C006	Grey Eagle Distributors	Storm Water Outfall	General Storm Water Industrial	11/29/2022
MO-R23D045	Air Products Prism Membranes	Storm Water Outfall	General Storm Water Industrial	5/8/2022
MO-R23D119	Graham Packaging Company	Storm Water Outfall	General Storm Water Industrial	5/8/2022
MO-R23D020	Grassworx LLC	Storm Water Outfall	General Storm Water Industrial	5/8/2022
MO-R23D027	Accella Polyurethanes	Storm Water Outfall	General Storm Water Industrial	5/8/2022
MO-G491341	Fred Weber, Inc- North	Outfall/Storm Water Outfall	General Storm Water Industrial	4/29/2022
MO-R203448	Accu-Glass LLC	Storm Water Outfall	General Storm Water Industrial	8/30/2024
MO-R203503	Deutsche Precision LLC	Storm Water Outfall	General Storm Water Industrial	8/30/2024
MO-R80C641	World Wide Technology LLC Adie Warehouse	Storm Water Outfall	General Storm Water Industrial	11/29/2022
MO-G350353	Sopus Products St Louis Dist Center	Outfall/Storm Water Outfall	General Storm Water Industrial	9/16/2022
MO-R130042	International Paper	Storm Water Outfall	General Storm Water Industrial	9/5/2023

Permit Number	Facility Name	Discharge Type	Permit Type	Permit Expiration
MO-R130065	Refresco Beverages Inc	Storm Water Outfall	General Storm Water Industrial	9/5/2023
MO-G970020	St Louis Composting MoPass Facility	Outfall/Storm Water Outfall	General Storm Water Industrial	8/5/2023
MO-R23A051	Buckeye International Inc	Storm Water Outfall	General Storm Water Industrial	10/30/2020
MO-R23A094	PCI, Inc.	Storm Water Outfall	General Storm Water Industrial	10/30/2020
MO-RA10151	Howard Bend Levee District	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA11178	Briar Crest	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA11092	Page Storage Complex	Storm Water Outfall	Land Disturbance	2/6/2022
MO-R100083	City of Maryland Heights	Storm Water Outfall	Land Disturbance	6/21/2022
MO-RA10959	Waterford Crossing	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA10770	United Healthcare Office Builidng	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA10683	St. Louis Ice Center	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA10629	Covenant Place II	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA10298	Villages at Willowbrooke - Plat 2	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA10240	Meridian Medical Technologies	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA10115	Nu Building	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA09492	McKelvey Woods Trail Phase 2	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA09399	MIllpark Office Warehouse	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA15574	Fort Mackay	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA15039	Arbor Gardens	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA13896	Homeprop19	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA14519	Bridgeway Park	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA13772	Safety National Casualty Corporation	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA13446	Petro-Mart Maryland Heights	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA13040	Wallis Energy Creve Coeur	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA12272	St. Louis Ice Center	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA12240	Pattonville Heights Middle School	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA12172	Bridgeway Park	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA12073	Ameren Dorsett Complex	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA11687	Ed Napleton Nissan	Storm Water Outfall	Land Disturbance	2/6/2022
MO-RA11677	QuikTrip #644	Storm Water Outfall	Land Disturbance	2/6/2022

5.1.5 Illicit Straight Pipe Discharges

Illicit straight pipe discharges of domestic wastewater are also potential point sources of bacteria. These types of discharges bypass treatment systems, such as a septic tank or a sanitary sewer, and discharge sewage directly to a stream or an adjacent land area (Brown et al. 2004). Illicit straight pipe discharges are illegal and are not authorized under the federal Clean Water Act. At present, there are no data about the presence or number of illicit straight pipe discharges in the Fee Fee

Creek (new) watershed. As noted in Section 5.1.3, illicit discharge detection and elimination is one of the six minimum control measures required by an MS4 permit. Such discharges are expected to be detected and eliminated in accordance with permitted conditions.

5.2 Nonpoint Sources

Nonpoint source pollution refers to pollution coming from diffuse, non-permitted sources that typically cannot be identified as entering a water body at a single location. They include all other categories of pollution not classified as being from a point source, and are exempt from Department permit regulations as per state rules at 10 CSR 20-6.010(1)(B)1. These sources involve stormwater runoff and are minor or negligible under low-flow conditions. Typical nonpoint sources of pollution that have the potential to influence water quality include various sources associated with runoff from agricultural and non-MS4 permitted urban areas, onsite wastewater treatment systems, and various sources associated with riparian corridor conditions.

5.2.1 Agricultural Runoff

Stormwater runoff from lands used for agricultural purposes are often sources of bacterial loading to water bodies. Activities associated with agricultural land uses that may contribute bacteria to a water body include manure fertilization of croplands or pastures and livestock grazing. As noted in Section 2.4, agricultural land coverages identified in the Fee Fee Creek (new) watershed include 5.5 percent of land under cultivated crops and 0.3 percent as hay or pasture land. The area of land in the watershed used for agricultural land use is located in the Missouri River flood plain and within the Howard Bend Levee District. Although some bacteria loading from agricultural areas may occur, due to the small proportion of area available for agricultural land uses, agricultural runoff is not expected to be a significant contributor of *E. coli* to Fee Fee Creek (new).

5.2.2 Urban Runoff (non-MS4 permitted areas)

Stormwater runoff from urban areas not having MS4 permits is considered a nonpoint source. In the Fee Fee Creek (new) watershed, stormwater runoff within the majority of the watershed falls within the jurisdiction of two MS4 permits. Therefore, for purposes of this TMDL report, urban runoff within the Fee Fee Creek (new) watershed is generally considered a potential point source contributor of *E. coli*. Minor development present within the Howard Bend Levee District, which is composed of a mix of developed and agricultural land uses adjacent to the Missouri River, may contribute some bacteria loading to Fee Fee Creek (new) via stormwater runoff from impervious surfaces. However, the overall contributions from these developed spaces is likely insignificant. Section 5.1.3 of this document provides a more detailed discussion of potential urban runoff bacteria contributions and MS4 permitting.

5.2.3 Onsite Wastewater Treatment Systems

When properly designed and maintained, onsite wastewater treatment systems (e.g., home septic systems) should not contaminate surface waters; however, onsite wastewater treatment systems do fail for a variety of reasons. When these systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration), there can be adverse effects to surface water quality (Horsley & Witten 1996). Failing onsite wastewater treatment systems are known sources of bacteria, which can reach nearby streams through both surface runoff and groundwater flows, thereby contributing bacteria loads under either wet or dry weather conditions. Onsite wastewater treatment systems may contribute bacteria to Fee Fee Creek (new) either directly or as a component of MS4-permitted stormwater.

The exact number of onsite wastewater treatment systems in the Fee Fee Creek (new) watershed is unknown. However, such systems are known to exist in areas of the county developed prior to the sewerage systems serviced by the Metropolitan St. Louis Sewer District (Jack Fischer, St. Louis County Public Works, personal communication, June 6, 2011). Since the district maintains parcel and billing information, an estimate of the number of parcels in the watershed without a sewer connection and potentially having an onsite system can be made. From information provided by the Metropolitan St. Louis Sewer District, it is estimated that approximately 368 parcels do not have a sewer connection. However, it is not known if onsite systems exist on each of these parcels.

As stated in Section 5.1.1 of this document, the Fee Fee Creek (new) watershed is serviced by the Metropolitan St. Louis Sewer District's Missouri River Wastewater Treatment Facility. Due to the availability of this sewer system and a St. Louis County ordinance requiring that a sewer connection to a building be made, if feasible, when a sanitary sewer line is within 200 feet of the property, many onsite wastewater treatment system eliminations have been made.

A study conducted by the Electric Power Research Institute suggests that up to 50 percent of onsite wastewater treatment systems in Missouri may be failing (EPRI 2000). Despite the lack of specific data showing that onsite wastewater treatment systems are a significant problem in the Fee Fee Creek (new) watershed, the available failure rate data suggests that any onsite wastewater treatment systems present in the watershed are potential contributors of bacteria to Fee Fee Creek (new). However, due to the overall urban nature of the watershed, the number of onsite wastewater treatment systems is expected to be low.

5.2.4 Riparian Corridor Conditions

Riparian corridor conditions can have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the detention, removal and assimilation of pollutants from runoff. Therefore, a stream with good riparian cover is better able to moderate the impacts of high pollutant loads than a stream with poor or no riparian cover. Table 7 presents land cover calculations for the riparian corridors within the Fee Fee Creek (new) watershed.

For this analysis, the same land cover data calculated in Section 2.4 of this document was used and the riparian corridor was defined as including a 30-meter area on each side of all streams in the watershed that are included in the 1:24,000-scale National Hydrography Dataset.[14] As is the case with the watershed as a whole, the dominant land cover types in the riparian corridor are those associated with varying degrees of development and imperviousness. More than 51 percent of the riparian corridor in the Fee Fee Creek watershed is categorized as having low to high intensity development and greater than 20 percent impervious coverage. Open space development, which contains less than 20 percent impervious cover, makes up approximately 25 percent of the riparian corridor. In total, developed land cover types account for almost 76 percent of the total coverage in the riparian corridor. Runoff from these areas that has come in contact with pet or wildlife wastes or from which SSOs have occurred can contribute bacteria loads to the MS4 or directly to an adjacent water body. For this reason, the riparian corridor condition within the watershed is a potential

[14] The National Hydrography Dataset is digital surface water data for geographic information systems (GIS) for use in general mapping and in the analysis of surface-water systems. Available URL: http://nhd.usgs.gov

contributing source of bacteria to Fee Fee Creek (new). Because available data is insufficient for distinguishing stormwater flows that directly enter the stream from those discharged through MS4 outfalls, for purposes of this TMDL report, bacterial contributions from riparian areas are included in the total MS4 wasteload allocation.

Table 7. Land cover in the riparian areas of the Fee Fee Creek (new) watershed

	Area		
Land Cover Type	**hectares (acres)**	**km^2 (mi^2)**	**Percent**
Barren Land	0.15 (0.37)	0.0015 (0.0006)	0.06
Developed, High Intensity	14.72 (36.36)	0.1472 (0.0568)	6.46
Developed, Medium Intensity	28.60 (70.67)	0.2860 (0.1104)	12.56
Developed, Low Intensity	74.42 (183.90)	0.7442 (0.2873)	32.68
Developed, Open Space	57.28 (141.53)	0.5728 (0.2211)	25.15
Cultivated Crops	11.81 (29.19)	0.1181 (0.0456)	5.19
Shrub and Herbaceous	0.36 (0.88)	0.0036 (0.0014)	0.16
Forest	29.57 (73.06)	0.2957 (0.1142)	12.99
Wetland	10.78 (26.63)	0.1078 (0.0416)	4.73
Open Water	0.02 (0.06)	0.0002 (0.0001)	0.01
Total:	227.70 (562.66)	2.2770 (0.8792)	100.00

6. Numeric TMDL Target and Modeling Approach

As noted in Section 3.2 of this document, Missouri's Water Quality Standards include a specific numeric *E. coli* water quality criterion for waters designated for whole body contact recreation category B. This *E. coli* concentration of 206 counts/100mL will serve as the numeric target for TMDL development. This targeted concentration will be expressed as daily loads that vary by flow using load duration curves. Achieving the targeted loads will result in attainment of the whole body contact recreation category B use as well as the secondary contact recreational use. Because the whole body contact recreation category B criterion is expressed as a geometric mean, fluctuations in instantaneous bacteria concentrations are expected and individual bacteria measurements greater than the TMDL target do not in and of themselves indicate a violation of water quality standards. The ultimate goal of this TMDL is to restore the bacteria impaired segments of Fee Fee Creek (new) to conditions that meet water quality standards through attainment of the whole body contact category B use.

A load duration curve also identifies the maximum allowable daily pollutant load for any given day as a function of the flow occurring that day, which is consistent with the Anacostia Ruling (*Friends of the Earth, Inc., et al v. EPA,* No 05-5010, April 25, 2006) and EPA guidance in response to this ruling (EPA 2006; EPA 2007a). EPA guidance recommends that all TMDLs and associated pollutant allocations be expressed in terms of daily time increments, and suggests that there is flexibility in how these daily increments may be expressed. EPA guidance indicates that where pollutant loads or water body flows are highly dynamic, it may be appropriate to use a load duration curve approach, provided that such an approach "identifies the allowable daily pollutant load for any given day as a function of the flow occurring on that day." In addition, for targets that are expressed as a concentration of a pollutant, it may be appropriate to use a table or graph to express

individual daily loads over a range of flows as a product of a water quality criterion, stream flow and a conversion factor (EPA 2006).

The load duration curve approach is also useful in identifying and differentiating between storm-driven and steady-input sources. The load duration curve approach provides a visual representation of stream flow conditions under which pollutant criteria exceedances have occurred, reveals critical conditions, and helps quantify the level of reduction necessary to meet the surface water quality targets for instream bacteria concentrations (Cleland 2002; Cleland 2003).

To develop the load duration curve, average daily flow data collected from January 1, 2004, to June 18, 2019, from the USGS gaging station 06935955 on Fee Fee Creek near Bridgeton, was used. Flow data from this gage were adjusted based on the ratio of the impaired stream's drainage area to the gage's drainage area. A detailed discussion of the methods and calculations used to develop the bacteria load duration curve in this TMDL report is presented in Appendix B.

7. Calculating Loading Capacity

A TMDL calculates the loading capacity of a water body and allocates that load among the various pollutant sources in the watershed. The loading capacity is the maximum pollutant load that a water body can assimilate and still meet water quality standards. It is equal to the sum of the wasteload allocation, load allocation, and the margin of safety:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

Where LC is the loading capacity, ∑WLA is the sum of the wasteload allocations, ∑LA is the sum of the load allocations, and MOS is the margin of safety.

According to 40 CFR 130.2(i), TMDLs can be expressed in terms of mass per unit time, toxicity, or other appropriate measures. For Fee Fee Creek (new), bacteria TMDLs are expressed as *E. coli* counts per day using a load duration curve. To develop a load duration curve, the numeric TMDL target is multiplied by flow to generate the maximum allowable load at different flows.[15] Figure 8 is the *E. coli* TMDL load duration curve calculated for the impaired segment of Fee Fee Creek (new). The y-axis describes bacteria loading as counts per day and the x-axis represents the frequency for which a particular flow is met or exceeded. The load duration curve presented in Figure 8 represents the loading capacity as a solid curve over the range of flows. Observed loads measured during the recreational season are plotted as points. The flow condition ranges presented in each figure illustrate general base flow and surface-runoff conditions that are consistent with EPA guidance about using load duration curves for TMDL development (EPA 2007b). Table 8 presents selected TMDL loading capacities and TMDL allocations, representing each flow condition along the load duration curves.[16]

[15] $Load\left(\frac{\text{count}}{\text{time}}\right) = Concentration\left(\frac{\text{count}}{\text{volume}}\right) * Flow\left(\frac{\text{volume}}{\text{time}}\right)$

[16] Due to the extremely large numbers associated with bacteria loads, *E. coli* values are presented using scientific notation.

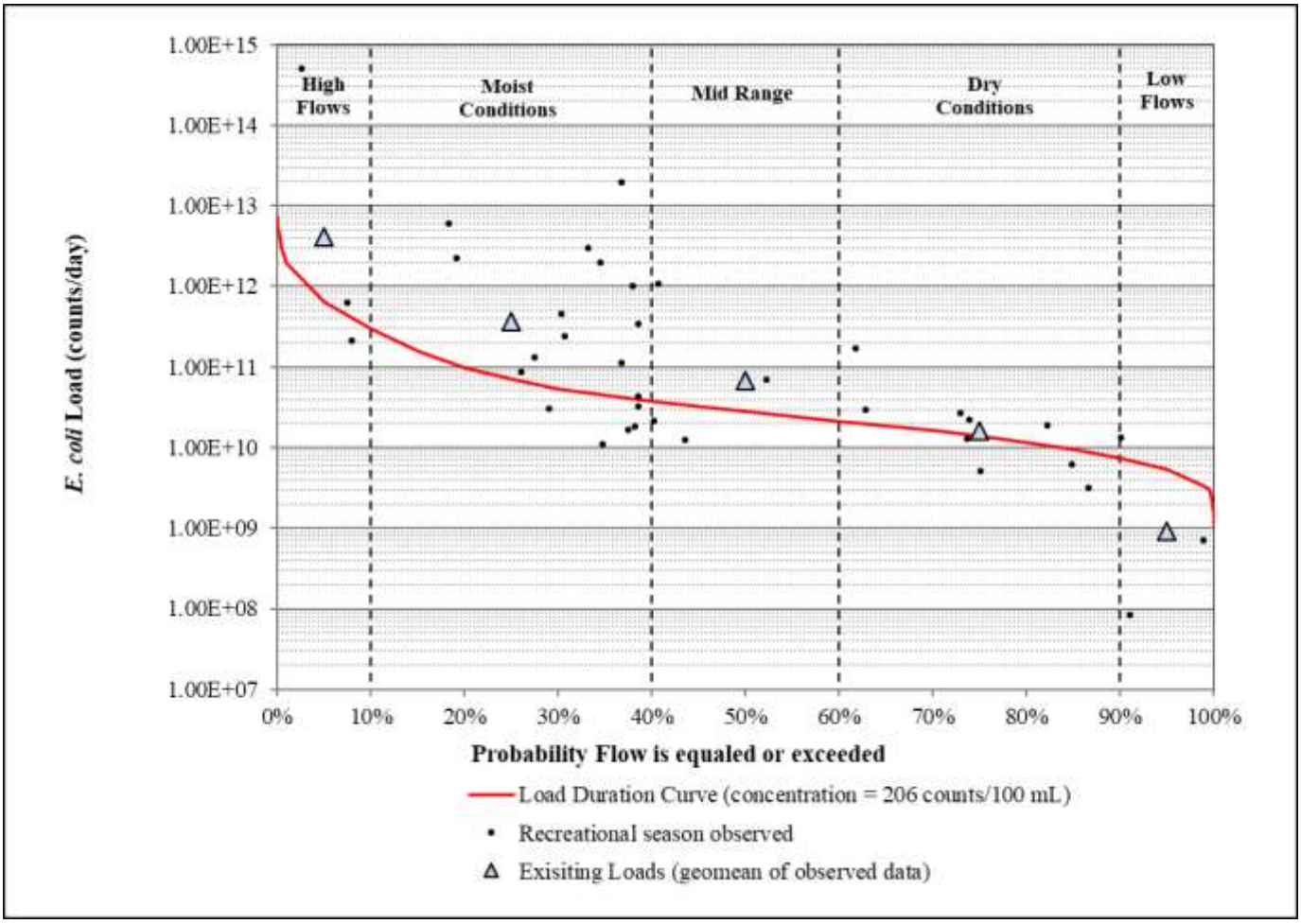

Figure 8. Fee Fee Creek, WBID 1704, load duration curve

Table 8. Selected *E. coli* TMDL values for Fee Fee Creek (new), WBID 1704

Percent of time flow exceeded	Flow m^3/s (ft^3/s)	TMDL (counts/day)	MS4 WLA (counts/day)	LA (counts/day)
95	0.03 (1.05)	5.29E+09	4.76E+09	5.29E+08
75	0.08 (2.78)	1.40E+10	1.26E+10	1.40E+09
50	0.16 (5.61)	2.83E+10	2.55E+10	2.83E+09
25	0.39 (13.90)	7.00E+10	6.30E+10	7.00E+09
10	3.64 (128.42)	6.47E+11	5.82E+11	6.47E+10

8. Wasteload Allocation (Point Source Load)

The wasteload allocation is the allowable amount of the loading capacity that is assigned to existing or future point sources. Typically, point sources are permitted with limits for a given pollutant that are the most stringent of either technology-based effluent limits or water quality-based effluent limits. Technology-based effluent limits are based upon the expected capability of a treatment method to reduce the pollutant to a certain concentration. Water quality-based effluent limits represent the most stringent concentration of a pollutant that a receiving stream can assimilate without violating applicable water quality standards at a specific location. Effluent limits or other

permit conditions must be consistent with the assumptions and requirements of TMDL wasteload allocations per 40 CFR 122.44(d)(1)(vii)(B).

8.1 Municipal and Domestic Wastewater Discharges

As noted in Section 5.1.1, domestic wastewater in the Fee Fee Creek (new) watershed is transferred through a sewerage system to a treatment works facility located outside of the watershed. Even so, sanitary sewer overflows still occur and are likely contributors of bacteria to Fee Fee Creek (new) and its tributaries. These discharges are not authorized under the federal Clean Water Act. For this reason, constructed sanitary sewer overflows in the Fee Fee Creek (new) watershed are given a wasteload allocation of zero. Elimination of bacteria loading from these sources will be accomplished through the requirements of the Metropolitan St. Louis Sewer District's consent decree.

8.2 Site-Specific Permitted Industrial and Non-Domestic Wastewater Facilities

Champ Landfill (MO-0097543) is the single industrial and non-domestic wastewater facility with a site-specific permit in the Fee Fee Creek (new) watershed. Site-specific permitted industrial and non-domestic wastewater facilities are typically not significant sources of bacteria. Additionally, Fee Fee Creek's designation as a metropolitan no-discharge stream creates a low likelihood that there will be any new dischargers of this type in the future. For these reasons, site-specific permitted industrial and non-domestic wastewater facilities are not assigned a portion of the calculated wasteload allocation. Any existing pollutant loading from this facility is assumed to be *de minimis* and is not expected to exceed the sum of the wasteload allocations.

8.3 Municipal Separate Storm Sewer System (MS4) Permits

Wasteload allocations for MS4 discharges are presented in Table 8 and are based on the proportion of the watershed contained within the U.S. Census Bureau urban area. Bacterial contributions from MS4 permitted entities are precipitation dependent and vary with flow. For this reason, wasteload allocation to the MS4s will also vary with flow. No other permitted facilities were found to significantly contribute bacteria loads to Fee Fee Creek (new), therefore the entire wasteload allocation is allocated to the MS4s. An aggregated wasteload allocation is used, because the significance of any highway contributions of bacteria in the watershed cannot be quantified and bacteria loading from highway areas is assumed to be infrequent and minor. Future bacteria monitoring may provide more specific information regarding each MS4 area's actual contributions, including specific sources and mechanisms of transport, thereby allowing permit conditions to be modified accordingly.

8.4 General Wastewater and Non-MS4 Stormwater Permits

Table 6 lists other facilities with general or non-MS4 stormwater permits. For purposes of this TMDL, the Department assumes that activities from these facilities in the watershed will be conducted in compliance with all permit conditions, including monitoring and discharge limitations and that compliance with these permits will result in bacterial loading at or below applicable targets. Because these facilities are not considered to be significant sources of bacteria loading to the impaired water bodies in the Fee Fee Creek (new) watershed, these facilities are not assigned a portion of the wasteload allocation and current permit conditions that would result in bacteria loading at or below current *de minimis* levels should be maintained.

8.5 Illicit Straight Pipe Discharges

Illicit straight pipe discharges are illegal and are not permitted under the federal Clean Water Act. For this reason, illicit straight pipe discharges are assigned a wasteload allocation of zero and any existing sources of this type must be eliminated. Where stormwater is regulated by MS4 permits, the detection and elimination of illicit discharges is a required permit condition.

8.6 Considerations for Future Sources

For this TMDL, no specific portion of the loading capacity is allocated to a reserve capacity. However, the wasteload allocations presented in this TMDL report do not preclude the establishment of future point sources of bacteria in the watershed. Any future point sources should be evaluated against the TMDL, the range of flows with which any additional bacterial loading will affect, and any additional requirements associated with antidegradation. Per federal regulations at 40 CFR 122.4(a), no permit may be issued when the conditions of the permit do not provide for compliance with the applicable requirements of the federal Clean Water Act, or regulations promulgated under the act. Additionally, 40 CFR 122.4(i) states no permit may be issued to a new source or new discharger if the discharge from its construction or operation will cause or contribute to violation of water quality standards. Future general (MO-G) and stormwater (MO-R) permitted activities that do not actively generate bacteria, and that operate in full compliance with permit conditions, are not expected to contribute bacteria loads above *de minimis* levels and will not result in loading that exceeds the sum of the TMDL wasteload allocations. New domestic wastewater treatment systems that undergo antidegradation review will be required to disinfect their effluent during the recreational season and, therefore, are not expected to cause or contribute to the impairment. Decommissioning of onsite wastewater treatment systems and connecting to a sewerage system for wastewater treatment will result in net pollutant reductions that are consistent with the goals of this TMDL. In some instances a potential source may be re-categorized from a nonpoint source to a point source (e.g., newly designated MS4s or other permitted stormwater). If such a source's magnitude, character, and location remain unchanged, then the appropriate portion of the load allocation may be assigned as a wasteload allocation.

9. Load Allocation (Nonpoint Source Load)

The load allocation is the allowable amount of the pollutant load that is assigned to nonpoint sources and includes all existing and future nonpoint sources, as well as natural background contributions (40 CFR §130.2(g)). Nonpoint sources identified in this TMDL report to be potential contributors of bacteria are onsite wastewater treatment systems, and minor amounts of agricultural and urban runoff from areas outside of the defined U.S. Census Bureau urban area, and primarily within the Howard Bend Levee District. If functioning properly, onsite wastewater treatment systems should not be contributing to the impaired condition of Fee Fee Creek (new). Onsite wastewater treatment systems are assigned a load allocation of zero. Other nonpoint sources potentially contribute bacteria loads through surface runoff. Load allocations for stormwater driven nonpoint sources are found in Table 8 and vary with flow. Load allocations were calculated as the remainder of the available loading capacity after allocations to the point source wasteload allocation.

10. Margin of Safety

A margin of safety is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. The margin of safety is intended to

account for such uncertainties in a conservative manner. Based on EPA guidance, the margin of safety can be achieved through two approaches:

- Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.
- Implicit - Incorporate the margin of safety as part of the critical conditions for the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

The margins of safety for this TMDL is implicit due to conservative assumptions in the modeling of the TMDLs, the use of multiple years of flow gage data collected under all flow conditions to create robust TMDL calculations, and the reduced uncertainty of the sources of impairment and their remediation through the Metropolitan St. Louis Sewer District's consent decree. Bacteria decay rates weren't applied and the direct recreation-season geometric mean was used for estimating the federal Clean Water Act required daily loading values.

11. Seasonal Variation

Missouri's water quality criteria for the protection of whole body contact recreation are applicable during the recreational season defined as being from April 1 to October 31. The TMDL load duration curve in Figure 8 represents stream flow under all conditions and uses flow data collected during all seasons. For this reason, the *E. coli* targets and allocations established in this TMDL report will be protective throughout the recreational season and during flow conditions associated with storm-driven events, including those associated with seasonal rain patterns, when bacteria loading is more likely. The advantage of the load duration curve approach for TMDL development is that all flow conditions are considered and the constraints associated with using a single-flow critical condition are avoided.

12. Monitoring Plans

The Department has not yet scheduled post-TMDL monitoring for Fee Fee Creek (new). Post-TMDL monitoring is usually scheduled and carried out by the Department approximately three years after the approval of the TMDL or in a reasonable period following completion of permit compliance schedules and the application of new effluent limits, or following significant implementation activities such as removal of constructed sanitary sewer overflows. The Department will routinely examine water quality data collected by other local, state, and federal entities in order to assess the effectiveness of TMDL implementation. Such entities may include the USGS, EPA, the Missouri Department of Health and Senior Services, the Missouri Department of Conservation, county health departments, and the Metropolitan St. Louis Sewer District. In addition, certain quality-assured data collected by universities, municipalities, private companies, and volunteer groups may potentially be considered for monitoring water quality following TMDL implementation.

13. Reasonable Assurance

Section 303(d)(1)(C) of the federal Clean Water Act requires that TMDLs be established at a level necessary to implement applicable water quality standards. As part of the TMDL process, consideration must be given to the assurances that point and nonpoint source allocations will be achieved and water quality standards attained. Where TMDLs are developed for waters impaired by point sources only, reasonable assurance is derived from the National Pollutant Discharge

Elimination System (NPDES), which is implemented through Missouri State Operating Permits. The wasteload allocation for MS4s will be implemented through Missouri MS4 permits with the ultimate goal to employ an iterative process using best management practices (BMPs) to the maximum extent practicable (MEP), assessment, and refocused BMPs to the MEP, leading toward attainment of water quality standards (64 FR 68753).

The consent decree established as part of the *United States of America and the State of Missouri, and Missouri Coalition for the Environment Foundation v. Metropolitan St. Louis Sewer District*, No. 4:07-CV-1120 requires specific eliminations and reductions of point sources in the Metropolitan St. Louis Sewer District's service area. This court-approved decree will provide an additional reasonable assurance of bacteria reductions in Fee Fee Creek (new) from point sources over a 14-year period (EPA 2011b).

Where a TMDL is developed for waters impaired by both point and nonpoint sources, point source wasteload allocations must be stringent enough so that in conjunction with the water body's other loadings (i.e., nonpoint sources) water quality standards are met. This generally occurs when the TMDL's combined nonpoint source load allocations and point source wasteload allocations do not exceed the water quality standards-based loading capacity and there is reasonable assurance that the TMDL's allocations can be achieved. Reasonable assurance that nonpoint sources will meet their allocated amount in the TMDL is dependent upon the availability and implementation of nonpoint source pollutant reduction plans, controls, or BMPs within the watershed. If BMPs or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs (40 CFR 130.2(i)). When a demonstration of nonpoint source reasonable assurance is developed and approved for an impaired water body, additional pollutant allocations for point sources may be allowed provided water quality standards are still attained. When a demonstration of nonpoint source reasonable assurance does not exist, or it is determined that nonpoint source pollutant reduction plans, controls or BMPs are not feasible, durable, or will not result in the required load reductions, allocation of greater pollutant loading to point sources cannot occur.

A variety of grants and loans may be available to assist watershed stakeholders with developing and implementing watershed plans, controls and practices to meet the required wasteload and load allocations in the TMDL and demonstrate additional reasonable assurance.

14. Public Participation

EPA regulations require that TMDLs be subject to public review (40 CFR 130.7). Fee Fee Creek (new) in St. Louis County is included on Missouri's EPA-approved 2018 303(d) List of impaired waters. A 45-day public notice and comment period for this TMDL report is scheduled from June 5 through July 20, 2020. Comments received and the Department's responses to those comments are maintained on file with the Department and on the Fee Fee Creek (new) TMDL record webpage at dnr.mo.gov/env/wpp/tmdl/1704-fee-fee-creek-record.htm.

Groups that directly received the public notice announcement for this TMDL include, but are not limited to:

- Missouri Clean Water Commission;

- Missouri Water Protection Forum;
- Missouri Department of Conservation;
- Missouri Department of Transportation;
- St. Louis County Soil and Water Conservation District;
- Metropolitan St. Louis Sewer District;
- St. Louis County Department of Health;
- St. Louis County Public Works;
- St. Louis County Council;
- University of Missouri Extension;
- Missouri Coalition for the Environment;
- Stream Team volunteers living in or near the watershed;
- Stream Teams United (formerly Missouri Stream Team Watershed Coalition);
- East-West Gateway Council of Governments; and
- Missouri state legislators representing areas within the watershed.

In addition to those groups directly contacted about the public notice, this TMDL report and an implementation strategies document are posted on the Department's TMDL webpage at dnr.mo.gov/env/wpp/tmdl/1704-fee-fee-creek-record.htm. All comments received during this period and the Department's responses to those comments are also available at this location.

The Department also maintains an email distribution list for notifying subscribers regarding significant TMDL updates or activities, including public notices and comment periods. Those interested in subscribing to these TMDL updates may do so by submitting their email address at public.govdelivery.com/accounts/MODNR/subscriber/new?topic_id=MODNR_177.

15. Administrative Record and Supporting Documentation

An administrative record about the Fee Fee Creek (new) TMDL has been assembled and is being kept on file with the Department. It includes any studies, data, and calculations on which the TMDL is based. This information is available upon request to the Department at dnr.mo.gov/sunshine-form.htm. Any request for information about this TMDL report will be processed in accordance with Missouri's Sunshine Law (Chapter 610, RSMO) and the Department's administrative policies and procedures governing Sunshine Law requests. For more information about open record/Sunshine requests, please consult the Department's website at dnr.mo.gov/sunshinerequests.htm.

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Appendix A
Recreational Season *E. coli* Data from the Fee Fee Creek watershed (2014 – 2018)

WBID	Site Code	Date	E. coli (#/100ml)	Flow ft^3/s (m^3/s)
1704	1704/1.2	4/9/2014	120	
1704	1704/1.2	5/7/2014	180	
1704	1704/1.2	6/11/2014	11000	
1704	1704/1.2	7/15/2014	9200	
1704	1704/1.2	8/13/2014	320	
1704	1704/1.2	9/10/2014	48392	
1704	1704/1.2	10/8/2014	1700	
1704	1704/1.2	4/15/2015	86	
1704	1704/1.2	5/13/2015	560	
1704	1704/1.2	8/12/2015	960	
1704	1704/1.2	9/16/2015	310	
1704	1704/1.2	10/14/2015	130	
1704	1704/1.2	4/13/2016	13000	
1704	1704/1.2	5/18/2016	4400	
1704	1704/1.2	6/15/2016	1800	
1704	1704/1.2	7/13/2016	310	
1704	1704/1.2	9/21/2016	370	
1704	1704/1.2	10/12/2016	75	
1704	1704/1.2	4/12/2017	110	
1704	1704/1.2	5/17/2017	52	
1704	1704/1.2	6/14/2017	110	
1704	1704/1.2	7/12/2017	74	
1704	1704/1.2	8/9/2017	5	
1704	1704/1.2	9/13/2017	75	
1704	1704/1.2	10/11/2017	6100	
1704	1704/1.2	4/9/2018	97	
1704	1704/1.2	5/15/2018	48392	
1704	1704/1.2	6/12/2018	360	
1704	1704/1.2	7/25/2018	41	
1704	1704/1.2	8/13/2018	370	
1704	1704/1.2	9/10/2018	550	
1704	1704/1.2	10/8/2018	5200	
1704	1704/1.2	4/8/2019	440	
1704	1704/1.2	5/14/2019	270	
1704	1704/1.2	8/12/2019	1800	
1704	1704/1.2	9/17/2019	170	
1704	1704/1.2	10/15/2019	230	

Appendix B
Development of Bacteria Load Duration Curves

B.1 Overview
The load duration curve approach was used to develop a TMDL for Fee Fee Creek (new). The load duration curve method allows for characterizing water quality concentrations (or water quality data) at different flow regimes and estimating the load allocations and wasteload allocations for each impaired segment. This method also provides a visual display of the relationship between stream flow and loading capacity. Using the duration curve framework, allowable loadings are easily presented.

B.2 Methodology
Using the load duration curve method requires a long time series of flow data, a numeric water quality target, and bacteria data from the impaired streams. Bacteria data from the impaired segments are converted into an instantaneous load using the flow measurements for the same date and are plotted along with the load duration curve to illustrate conditions when the water quality targets may have been exceeded.

To develop a load duration curve, a long record of average daily flow data from a gage (or multiple gages) that is representative of the impaired reach is used. The flow record should be of sufficient length to be able to calculate percentiles of flow. If a flow record for an impaired stream is not available, then a synthetic flow record is needed. For this TMDL, flow records from January 1, 2004, to June 18, 2019, collected from the gage identified in Table B.1 were used. The modeling approach assumes that discharge at the outlet of the impaired watershed is proportional to the discharge from the USGS gage station. Therefore, average daily flow values were corrected based on the proportion of the area draining to the impaired watershed to that draining to the flow gage. The developed flow duration curves for the impaired water bodies are presented in Figure B.1. These flows in units of ft^3/second are then multiplied by the applicable water quality target (206 counts/100 mL) and a conversion factor of 24,465,715 in order to generate the allowable load in units of counts/day.[17] Despite the varying load, the targeted concentration is constant at all flow percentiles and reflects the static nature of the water quality standards.

Table B.1. Drainage areas of gage and impaired waterbodies and correction factors

Location:	USGS Gage 06935955	WBID 1704
Drainage Area:	30.30 km^2 (11.70 mi^2)	48.15 km^2 (18.59 mi^2)
Correction Factor:	--	1.59

[17] $Load\ \left(\frac{\text{count}}{\text{day}}\right) = \left[Target\left(\frac{\text{count}}{\text{100ml}}\right)\right] * \left[Flow\ \left(\frac{feet^3}{s}\right)\right] * [Conversion\ Factor]$

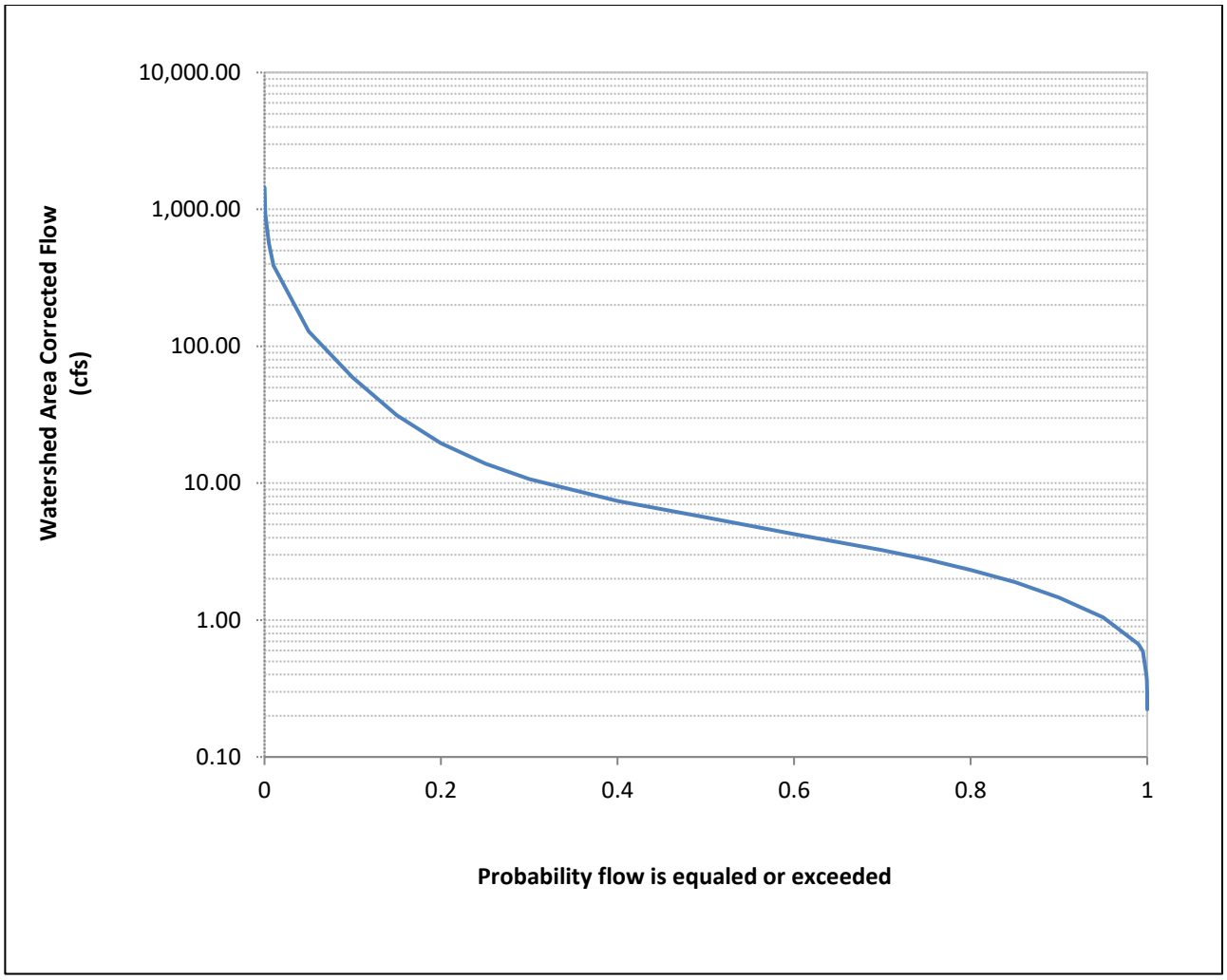

Figure B.1 Flow duration curve for Fee Fee Creek (new), WBID 1704.